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Applicant(s):	BEN-DAVID, Ilan et al.	Examiner:	SPAR, Ilana L.
Serial No.:	10/588,755	Group Art Unit:	2629
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Title:	METHOD, DEVICE AND SYSTEM OF DISPLAYING A MORE-THAN-THREE PRIMARY COLOR IMAGE		

APPEAL BRIEF

Mail Stop Appeal Brief – Patents
Board of Patent Appeals and Interferences
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

I. Real Party in Interest

The real party in interest is Genoa Color Technologies, Ltd.

II. Related Appeals and Interferences

There are no related appeals or interferences known to Appellants.

III. Status of the Claims

Claims 1-40 are pending and have been rejected in a final Office action dated June 17, 2011. The rejection of claims 1-40 is appealed herein.

IV. Status of Amendments

An amendment was filed after the rejection in the final Office action dated June 17, 2011. As indicated in the Advisory Action dated September 27, 2011, the amendments have been entered.

V. Summary of Claimed Subject Matter

The following provides a brief description of the present application and of the subject matter recited in independent claim 1 and 17 involved in this Appeal. A brief description of the subject matter recited in dependent claims 6 and 13 also provided. In the below description, page and line numbers refer to the specification of the present application as filed.

The present applications relates to liquid crystal display systems having sub-pixels that include four or more primary colors, and a method for converting standard three-color input data into a more-than-three color format suitable for driving a multi-primary liquid crystal display (LCD).

An LCD are made up of an array of pixels, each of which is made up of different colored sub-pixels. The display is backlit by white illumination, which is filtered through each sub-pixel, which typically includes an LCD element and a color filter. For each sub-pixel, the transmissivity of the LCD element is controlled by a gray-scale value to obtain a desired light intensity, and the light is then filtered through a respective color filter, e.g., red, blue, green, etc. The LCD driver is able to control individual sub-pixels by controlling circuits associated with row lines, and circuits associated with column lines, and through active-matrix addressing.

According to embodiments of the invention, standard three-color input data may be converted into a more-than-three color format suitable for driving a multi-primary liquid crystal display (LCD). As claimed, the conversion process may involve a first conversion from three-color format into an intermediate format of four or more primary colors, and then a second conversion that considers display attributes of the particular LCD and/or image attributes of the particular input image. For example, display attributes may include the spatial configuration of sub-pixels, a configuration of defective sub-pixels, brightness non-

homogeniety, or color non-homogeniety of the particular device. Likewise, for example, input image attributes may include perceived bit-depth of the particular image being displayed, its smoothness, brightness, or color uniformity.

Taking the example of defective display pixels, if one of the sub-pixels of a particular pixel is defective, the conversion process of the present invention may compensate for such defective sub-pixels by reproducing the desired color by modifying the intensity values of the non-defective sub-pixels. As illustrated in Fig. 5, a color gamut for six primaries may include red (R), green (G), blue (B), cyan (C), yellow (Y) and magenta (M) as primaries. Thus, for example, a replacement color gamut for a defective pixel may be an RGB or YCM gamut. The display may keep track of the locations of one or more defective pixels and/or the identity of one or more defective primary color sub-pixels, and use the conversion process of the present invention to compensate accordingly. Thus, for example, if, based on the location of a pixel, the conversion controller determines that the pixel is defective, the second converter may convert the intermediate sub-pixel (in a six primary color format) using a different color gamut (e.g., an RGB or YMR color gamut). Other display and/or image attributes may also be factored into the second conversion, such as position-dependent homogeniety correction factors to account for brightness variations across the panel.

Independent claim 1 recites a conversion module that includes a first convertor for converting image data of at least three primary colors into intermediate sub-pixel data of four or more primary colors (paragraphs [0045], [0053]). A second converter converts intermediate sub-pixel data into converted sub-pixel data using at least one conversion matrix, and the converted sub-pixel is determined based on the intermediate sub-pixel data and a position of the display pixel (paragraphs [0070], [0080], [0084]). A controller determines one or more values of the at least one conversion matrix based on display and/or image attributes and provides this conversion matrix to the second converter (paragraphs [0100]-[0105]). Independent claim 17 recites a method that includes determining values of at least one conversion matrix based on at least one display attribute and at least one image attribute, and converting intermediate sub-pixel data of four or more primary colors into converted sub-pixel data using the conversion matrix. Id.

Claim 6 recites a combiner to combine a first conversion of image data into first intermediate sub-pixel data of four or more colors and a second conversion of image data into second intermediate sub-pixel data of three or more colors (paragraphs [0072]-[0073]).

Claims 9 and 25 recite that the controller of claim 1 is able to determine values of the conversion matrix based on one or more timing signals related to image data (paragraphs [0044], [0095]).

Claims 13 and 28 recite that display attributes may include one or more of: defective sub-pixel configuration, a brightness non-homogeniety of the device, and a color non-homogeniety of the device (paragraphs [0026], Fig. 2, Fig. 7).

Claims 14 and 29 recite that image attributes include one or more of: perceived bit-depth of pixels, a viewed smoothness of the image, brightness/color uniformity of the image, and a rendering scheme of the image (paragraphs [0027], [0066], [0077]).

VI. Grounds of Rejection to be Reviewed on Appeal

The following basis for rejection is to be reviewed in this Appeal:

A. Whether claims 1, 10, 13, 14, 17, 26, 28, and 29 are unpatentable under 35 U.S.C. § 102(e), over U.S. Pat. No. 6,897,876 ("Murdoch").

B. Whether claims 6, 7, 12, 22, and 23 are unpatentable under 35 U.S.C. § 103(a) over Murdoch in view of U.S. Pat. No. 5,563,725 ("Kumada").

C. Whether claims 9 and 25 are unpatentable under 35 U.S.C. § 103(a) over Murdoch in view of U.S. Pat. No. 5,896,178 ("Inoue").

D. Whether claims 11, 15, 16, 18, 27, 30, 32, 36, and 38-40 are unpatentable under 35 U.S.C. § 103(a) over Murdoch in view of U.S. Pat. No. 7,365,722 ("Lee").

VII. Arguments

A. The Murdoch Reference

The method disclosed by Murdoch is directed to transforming three color image signals for display on a color OLED display using four color primaries, such as RGBW. Murdoch is generally directed to a particular method of resampling color data in one format or spatial arrangement to fit another format or spatial arrangement, in a way that increases the lifetime of OLED displays, maintains color accuracy, and fits a spatial configuration of OLED pixels (col. 3, lines 26-54; col. 4, lines 5-13). As discussed in detail below, it is the resampling from one arrangement of sub-pixels within a pixel to another arrangement of sub-pixels within the pixel that the Examiner has cited in rejecting the present claims.

Murdoch discloses that "the method of the present invention can be implemented in the context of an image processing method that <u>allows the incoming data to be spatially resampled to the RGBW pattern of OLEDs on the OLED display device</u>" (col 11, lines 11-13, emphasis added). Murdoch discusses several ways that this may be implemented with a spatial resampling method, including one such implementation shown in Fig. 5. The process first receives a three-color input signal, e.g., RGB (step 60); the spatial format for the input is determined (step 62; col. 11, lines 34-36). Then, it is determined whether "the three color input signals are rendered for OLEDs that have different spatial locations" (step 64, col. 11, lines 38-40). If the input signals are rendered for different spatial locations than the OLED display, then the input signal are resampled so that each spatial position in the resampled input signal (R'G'B') represents a spatial position in the OLED display (step 66). Finally, the resampled three color input is converted to a four color output signal, e.g., RGBW (step 68, Fig. 2). Alternatively, if the input signal is not resampled, and the input three color signal is first converted into a four color output signal, then the four-color output signal may be resampled for proper display on the OLED device (step 70, col. 11, lines 48-53).

It is clear that the resampling method described by Murdoch is for displaying input signals on a device having four primary color sub-pixels at the proper <u>resolution</u> for the device. For example, if the original three-color input image signal has a first, low resolution of 960x480 pixels, and a four-color OLED display has a second, high resolution of 1024x768

pixels, the three color input signal requires both conversion to a four color signal and a resampling to fit the OLED display resolution. Since the input image signal has a smaller resolution than the OLED display resolution, the resampling step is required to evenly distribute the pixels in the 960x480 input across the 1024x768 pixels of the display, e.g., by interpolating missing values.

B. Murdoch fails to Disclose or Render Obvious All Elements of Claims 1-40

In the below discussion, claims 1, 13, 14, 17, 28, 29, and 38 are discussed in detail. It will be understood that similar arguments are applicable to additional pending claims.

Claim 1 recites a color display device for displaying a more-than-three color image, the device comprising a driver control module to controllably activate one or more drivers of an array of sub-pixel elements of at least four different colors based on image data representing pixels of said color image in terms of at least three data components. In relevant part, the driver control module includes:

> a first converter for converting said image data into intermediate sub-pixel data of four or more primary colors, and
>
> a second converter for converting said intermediate sub-pixel data into said converted sub-pixel data using at least one conversion matrix, wherein the converted sub-pixel data depends on the intermediate sub-pixel data and a position of the pixel displaying the data, wherein data for each of said four or more primary colors of said converted sub-pixel data is in gray-level format, and

As discussed below, Murdoch's resampling from one resolution to another resolution does not amount to "a second converter for converting said intermediate sub-pixel data into said converted sub-pixel data using at least one conversion matrix, wherein the converted sub-pixel data depends on the intermediate sub-pixel data and a position of the pixel displaying the data[.]"

1. Murdoch does not disclose or render obvious converting sub-pixels based on intermediate sub-pixel data and a position (Claims 1 and 17)

In the final Office action, the Examiner stated that Murdoch teaches first converting an image of three primary colors into intermediate sub-pixel data of four or more primary colors, and next converting the intermediate sub-pixel data into converted sub-pixel data, depending on a position of the pixel displaying the data. The Examiner referenced column 11, lines 11-32. This passage discloses, in relevant part:

> [T]he three-color input signal is typically converted to a four (or more) color signal using a method such as the methods described above. A resampling is then performed to determine the appropriate intensities for the OLEDs within the four or more color display device. <u>This resampling process may consider relevant display attributes, such as the sampling area, sampling location, and size</u> of each intended OLED. (emphasis added)

Murdoch further explains the resampling process to include:

> a step of determining the intended RGB display format for the input data. If this step determines that the image data has already been sampled for a display device having a particular spatial arrangement of OLEDs, a preliminary resampling can be performed that results in the three color input signals representing the same spatial location within a pixel. This preliminary step allows the subsequent three to four color transformation to determine four color values at each spatial location on the display device. (col. 11, lines 23-32).

In other words, if the input image data is already in a format that is in the same spatial arrangement as a particular OLED display, the input image data has the same pixel resolution as the OLED display. At each spatial location, the three-color input pixel is then converted to a four-color output signal, a conversion that is <u>independent of position</u>. The passage cited by the Examiner, therefore, does not teach first converting pixels into intermediate sub-pixels, which are then transformed into converted sub-pixels <u>based on a position</u>.

In the advisory action, the Examiner broadly interpreted this portion of Murdoch to mean that resampling may consider any multitude of factors including "any conversion method being based at least in part on position of a sub-pixel within the overall display." However, it is clear that Murdoch only discusses a resampling process in the context of

spatial interpolation of an input signal. Indeed, Murdoch describes this purpose of resampling:

> Resampling may be performed either to resample data from a format intended for display on a prior art stripe or delta pattern as shown in FIG. 6a and FIG. 6b to a format 35 with a color signal representing a value at every spatial location or it may be used to resample data from a format with a color signal at every spatial location to a pattern that includes a white subpixel, such as the stripe pattern shown in FIG. 8a or the quad pattern shown in FIG. 8b (column 13, lines 33-43).

Murdoch continues with a description of a resampling method known in the art. First, a sample point with a spatial location is selected from the grid where conversion is desired. If the sample point does not exist in the input signal with the corresponding spatial location, the sample point may be determined by taking a weighted average of neighboring pixels in the input signal. (col. 13, line 52 to col. 14, line 6). The "same process is repeated 146 for each grid position in the desired sampling grid and then for each color signal" (col. 14 lines 7-8). The result of resampling is a conversion "from a three color signal with one assumed spatial sampling to a more than three color signal with a desired spatial sampling" (col. 14 lines 12-14). Therefore, the resampling process in Murdoch occurs at each spatial location on an output grid, and does not depend on a position of each pixel. That is, <u>the same resampling process is applied in a similar manner to each pixel</u>.

In contrast, as recited in claim 1, the conversion is based on particular display and/or image attributes. Thus, <u>at each pixel position</u>, the second converter uses the values of the conversion matrix that <u>corresponds to the particular pixel position</u>, and converts intermediate sub-pixel data of four or more primary colors into converted sub-pixels for that position, based on the relevant display and/or image attributes. Thus, for example, the conversion itself depends on the location of the pixel, rather than applying the same conversion to each pixel across the display, as Murdoch describes. For example, in the present invention, values of a conversion matrix may depend on a display attribute such as a configuration of defective pixels. The conversion matrix may provide information to the second converter on the location of defective pixels in a display. After the first conversion from an input of three primary colors to intermediate sub-pixels data of six primary colors, the second converter, using the defective pixel location information from conversion matrix, may convert the

intermediate sub-pixels into converted sub-pixels. These converted sub-pixels at defective pixel locations may compensate for the defective pixels on the display by reproducing the input image color with a different color gamut. However, the converted sub-pixels that at other locations that are not defective will not have the same gamut conversion as the sub-pixels at defective locations. Therefore, the converted sub-pixels in the present invention are based on a location and the intermediate sub-pixel values, whereas Murdoch converts three color inputs to four color inputs at each location in the same manner, without depending on the location of the display pixels.

2. Murdoch does not disclose or render obvious that conversion depends on the display attributes of Claims 13, 28, and 38

In the final Office action, the Examiner rejected claims 13 and 28, stating that Murdoch teaches depending conversion on display attributes such as a configuration of one or more defective sub-pixel elements or brightness/color non-homogeneity of the display. The Examiner again referred to column 11, lines 23-32, stating that "the spatial arrangement of the sub-pixels must be compensated for to eliminate brightness or color non-homogeneity" (Page 5). However, Murdoch does not mention any of the display attributes described in claim 13 and 28 in any part of the application. Further, eliminating bright or color non-homogeneity requires applying correction factors at particular positions rather than considering the spatial arrangement of sub-pixels. As explained in paragraph [0080] of the present application:

> A variation of the brightness values of each of the primaries across the display may be determined, e.g., during a testing process, and based on the brightness variation, a set of position-dependent homogeneity correction factors corresponding to each of the primary colors may be calculated. For example, each of the homogeneity correction factors may correspond to one of the primaries and a position on the display. Data representing the position-dependent homogeneity correction factors corresponding to each of the primary colors may be stored, for example, in memory 314. The homogeneity correction factor data may be subsequently used in order to correct a brightness variation across the display, as described below (emphasis added).

Eliminating non-homogeneity requires "maintaining a relatively fixed ratio between the brightness values of the different primaries across the display" (paragraph [0079]). Thus,

correcting brightness values at different positions helps to maintain a constant brightness ratio in the display. Since the brightness or color non-homogeneity of a display does not depend at all on the spatial arrangement of sub-pixels on the display, Murdoch does not teach or disclose any of the display attributes of claim 13 or 28.

3. Murdoch does not disclose or render obvious that conversion depends on the image attributes of claim 14 and 29

In the final Office action, the Examiner rejected claims 14 and 29, stating that Murdoch teaches depending conversion on input image attributes such as perceived bit-depth of pixels, a viewed smoothness, brightness uniformity, color uniformity, and a rendering scheme. The Examiner again referred to column 11, lines 17-22, stating that "the intensities of the sub-pixels must be adjusted to create a uniform brightness and color" (final Office action, pp. 5, 7). However, Murdoch does not discuss or disclose any such input image data attributes that are factored into its conversion method. Further, the mere adjustment of sub-pixel intensities does not indicate that conversion depends on any of these input image attributes. Murdoch teaches resampling of the input image to determine the appropriate intensities to display on an OLED device (col. 11, lines 17-19). The image attribute that Murdoch would most likely consider in the resampling process would be the pixel resolution of the input image, rather than the image attributes described in claims 14 and 19.

C. None of the Kumada, Inoue, and Lee references cure the deficiences of the Murdoch reference

In the final rejection, the Examiner rejected claims 6, 7, 12, 22, and 23 as being obvious over Murdoch and Kumada, claims 9 and 25 over Murdoch and Inoue, and claims 11, 15, 16, 18, 27, 30, 32, 36, and 38-40 over Murdoch and Lee. However, it is respectfully submitted that given the deficiences in the Murdoch reference discussed above, no combination of these prior art references would teach the claimed invention.

Conclusion

It is respectfully submitted that claims 1, 5, 7, 9-18, 22-23, 25-30, 32, 36-40 are allowable and that the rejections of claims 1, 5, 7, 9-18, 22-23, 25-30, 32, 36-40 in the final Office action of June 17, 2011 be reversed.

Respectfully submitted,

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VIII. Claim Appendix

1. (Rejected) A color display device for displaying a more-than-three color image, the device comprising a driver control module to controllably activate one or more drivers of an array of sub-pixel elements of at least four different colors based on image data representing pixels of said color image in terms of at least three data components wherein said driver control module comprises:

   a conversion module for converting said image data into converted sub-pixel data representing said color image in terms of four or more primary colors said conversion module comprises:

      a first converter for converting said image data into intermediate sub-pixel data of four or more primary colors, and

      a second converter for converting said intermediate sub-pixel data into said converted sub-pixel data using at least one conversion matrix, wherein the converted sub-pixel data depends on the intermediate sub-pixel data and a position of the pixel displaying the data, wherein data for each of said four or more primary colors of said converted sub-pixel data is in gray-level format, and

   a controller to control said conversion module to convert said image data into said converted sub-pixel data based on said one or more display-attributes and said one or more image-attributes, wherein said controller is able to determine one or more values of said at least one conversion matrix based on at least one display attribute related to said display device and at least one image attribute related to said color image, and to provide said values of said at least one conversion matrix to said second converter.

2-4 (Canceled)

5. (Cancelled)

6. (Rejected) The device of claim 1, wherein said conversion module comprises:

a first converter to convert the image data representing pixels of said color image in terms of at least three data components into first intermediate sub-pixel data of said four or more colors;

a second converter to convert the image data representing pixels of said color image in terms of at least three data components into second intermediate sub-pixel data of three or more colors; and

a combiner to combine said first and second intermediate sub-pixel data into said converted sub-pixel data,

wherein said controller is able to control at least one of said first and second converters and said combiner based on at least one of said display attributes and image attributes.

7. (Rejected) The device of claim 6, wherein said second converter is able to convert the image data representing pixels of said color image in terms of at least three data components using at least one conversion matrix, which is based on at least one of said display attributes and said image attributes.

8. (Cancelled)

9. (Rejected) The device of claim 1, wherein said controller is able to determine one or more values of said conversion matrix based on one or more timing signals related to said image data.

10. (Rejected) The device of claim 1, wherein said driver control module comprises a sub-pixel processor to process said converted sub-pixel data, wherein said controller is able to control said processor to generate a sub-pixel signal based on at least one of said image attributes and said display attributes.

11. (Rejected) The device of claim 10 comprising an interface module to generate driver signals based on said sub-pixel data signal.

12. (Rejected) The device of claim 1 comprising a memory to store display-related data representing said one or more display attributes.

13. (Rejected) The device of claim 1, wherein said one or more display-attributes comprise at least one attribute selected from the group consisting of a configuration of one or more defective sub-pixel elements within said array, a brightness non-homogeneity of said display device, and a color non-homogeneity of said display device.

14. (Rejected) The device of claim 1, wherein said one or more image-attributes comprise one or more attributes selected from the group consisting of a perceived bit-depth of pixels of at least part of said image, a viewed smoothness of at least part of said image, a brightness uniformity of at least part of said image, a color uniformity of at least part of said image, and a rendering scheme to be applied to at least part of said image.

15. (Rejected) The device of claim 1, comprising a display panel containing said driver control module and said array of sub-pixel elements.

16. (Rejected) The device of claim 1, wherein said array of sub-pixel elements comprises an array of liquid crystal elements.

17. (Rejected) A method of displaying a more-than-three color image on a display device comprising controllably activating one or more drivers of an array of sub-pixel elements of at least four different colors, based on image data representing pixels of said color image in terms of at least three data components, said one or more drivers to perform:

    determining values of at least one conversion matrix based on at least one display attribute related to said display device and at least one image attribute related to said color image;

    converting said image data into intermediate sub-pixel data of four or more primary colors; and

    using said determined values of said at least one conversion matrix to convert said intermediate sub-pixel data into converted sub-pixel data, said converted sub-pixel data representing said color image in terms of four or more primary colors, wherein data for each of said four or more primary colors of said converted sub-pixel data is in gray-level format, wherein the converted sub-pixel data depends on the intermediate sub-pixel data and a position of the pixel displaying the data.

18. (Rejected) The method of claim 17 comprising generating one or more driver signals for activating said drivers based on one or more display attributes related to said display device and one or more image attributes related to said color image.

19-21. (Canceled)

22. (Rejected) The method of claim 17, wherein converting said image data comprises:

    converting the image data representing pixels of said color image in terms of at least three data components into first intermediate sub-pixel data of said at least four primary colors;

    converting the image data representing pixels of said color image in terms of at least three data components into second intermediate sub-pixel data of at least three primary colors;

    combining said first and second intermediate sub-pixel data into said converted sub-pixel data; and

    controlling at least one of converting said image data into said first intermediate sub-pixel data, converting said image data into said second intermediate sub-pixel data, and said combining, based on at least one of said display attributes and said image attributes.

23. (Rejected) The method of claim 22, wherein converting said image data into said second intermediate sub-pixel data comprises converting said image data using at least one conversion matrix, which is based on at least one of said display attributes and said image attributes.

24. (Cancelled)

25. (Rejected) The method of claim 17 comprising determining one or more values of said conversion matrix based on one or more timing signals related to said image data.

26. (Rejected) The method of claim 17 comprising processing said converted sub-pixel data and generating a sub-pixel signal based on at least one of said image attributes and said display attributes.

27. (Original) The method of claim 26 comprising generating said driver signals based on said sub-pixel data signal.

28. (Rejected) The method of claim 18, wherein said one or more display-attributes comprise at least one attribute selected from the group consisting of a configuration of one or more defective sub-pixel elements within said array, a brightness non-homogeneity of said display device, and a color non-homogeneity of said display device.

29. (Rejected) The method of claim 18, wherein said one or more image-attributes comprise one or more attributes selected from the group consisting of a perceived bit-depth of pixels of at least part of said image, a viewed smoothness of at least part of said image, a brightness uniformity of at least part of said image, a color uniformity of at least part of said image, and a rendering scheme to be applied to at least part of said image.

30. (Rejected) A color display system for displaying a more-than-three color image, the system comprising:

    an input interface to generate image data signals representing pixels of said color image in terms of at least three data components; and

    a driver control module to controllably activate one or more drivers of an array of sub-pixel elements of at least four different colors, based on said image data signals, wherein said driver control module is able to generate one or more driver signals for activating said drivers based on one or more

position-dependent display attributes independently related to individual positions in said display device and one or more image attributes related to said color image.

31. (Cancelled)

32. (Rejected) The system of claim 30, wherein said driver control module comprises:

a conversion module to convert said image data signals into converted sub-pixel data signals representing said color image in terms of four or more colors; and

a controller to control said conversion module to convert said image data signals based on said one or more display-attributes and said one or more image-attributes, wherein data for each of said four or more primary colors of said converted sub-pixel data is in gray-level format.

33-35. (Canceled)

36. (Rejected) The system of claim 32, wherein said driver control module comprises a sub-pixel processor to process said converted sub-pixel data signals, wherein said controller is able to control said processor to generate a sub-pixel signal based on at least one of said image attributes and said display attributes.

37. (Canceled)

38. (Rejected) The system of claim 30, wherein said one or more display-attributes comprise at least one attribute selected from the group consisting of a

configuration of one or more defective sub-pixel elements within said array, a brightness non-homogeneity of said display device, and a color non-homogeneity of said display device.

39. (Rejected) The system of claim 30, wherein said one or more image-attributes comprise one or more attributes selected from the group consisting of a perceived bit-depth of pixels of at least part of said image, a viewed smoothness of at least part of said image, a brightness uniformity of at least part of said image, a color uniformity of at least part of said image, and a rendering scheme to be applied to at least part of said image.

40. (Rejected) The system of claim 30, comprising a display panel containing said driver control module and said array of sub-pixel elements.

IX. Evidence Appendix

None.

X. Related Proceedings Appendix

None.